EPA/AMD/R04-97/183
1997

EPA Superfund
Record of Decision Amendment:

ARLINGTON BLENDING & PACKAGING
EPA ID: TND980468557
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ARLINGTON, TN
07/24/1997

<IMG SRC 971830>

ARLINGTON BLENDING & PACKAGING SUPERFUND SITE

AMENDED RECORD OF DECISION
July 1997

<IMG 07183A>

United States Environmental Protection Agency
Region IV

59 0008

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AMENDED RECORD OF DECISION

THE DECLARATION

SITE NAME AND LOCATION

Arlington Blending & Packaging Site
Arlington, Shelby County, Tennessee

STATEMENT OF BASIS AND PURPOSE

This decision document describes a fundamental change to the ground-water restoration approach presented in the June 1991 Record of Decision (ROD) for the Arlington Blending & Packaging Site (Site). As the result of information developed since the original ROD was finalized, EPA Region 4 has decided to employ monitored natural attenuation as the new Selected Remedy, Site-specific characterization data indicated that shallow aquifer ground-water plumes flowing beneath and downgradient of the Site do not pose a realistic threat to human health or the environment. This change to the original Selected Remedy was chosen in accordance with CERCLA, as amended, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which states that natural attenuation is generally recommended in special situations where ground-water is unlikely to be used in the foreseeable future and therefore can be remediated over an extended period of time.

Further, EPA has determined that all physical construction related to this remedy has been completed. Therefore, the site qualifies for inclusion on the Construction Complete List and this amendment to the ROD also serves as the Prelimiry Closeout Report. EPA Region 4 and the State of Tennessee Division of Superfund conducted a final inspection on 11 April 1997, to verify that the Arlington Blending Site Group (the potentially responsible party) carried out the provisions of the remedial action in accordance with the site remedial design plans and specifications.

The selection of monitored natural attenuation by EPA Region 4 for ground-water restoration at the Site does not change the original ground-water performance standards (see Section 2.1). Thus, the goal of the Selected Remedy remains to restore ground water to its beneficial uses by attaining remediation levels throughout the contaminant plumes that have migrated beyond the edge of the area where contaminated site soils were excavated. This decision is based on the administrative record for this site.

The State of Tennessee concurs with this amendment to the ROD.

RATIONALE FOR SELECTION OF NATURAL ATTENUATION AS GROUND-WATER RESTORATION REMEDY

EPA Region 4 believes that the documented hazardous substances present in the shallow aquifer beneath this site do not pose a current or likely future imminent and substantial endangerment to public health, welfare, or the environment.

Therefore, even though the pump and treat remedy selected in the June 1991 ROD is an appropriate selected remedy, its implementation is not necessary to protect human health and the environment. EPA Region 4 views the use of monitored natural attenuation as a complement to the source control and soil treatment activities completed in July 1996 and the existing institutional controls in place at the Site. The following information has been obtained since the original remedy was selected:

- The confining layer beneath the contaminated shallow aquifers has been confirmed to be intact beneath the area of ground-water contamination. The presence of this confining layer makes the possibility of vertical migration of contaminants into the Memphis sand aquifer unlikely

- the Loosahatchie River Canal (LRC) serves as a point of entry for site ground-water plume

- ground-water contaminant levels are not substantial enough to adversely impact LRC water quality

- 41,431 tons of source (contaminated) soils were excavated and treated during early 1996 (more than ninety percent of the total source soils)

- existing Shelby County regulations prohibit construction of ground-water wells for domestic uses where a public water system is available and within a half-mile of a listed Superfund site; these regulations would, therefore, preclude human exposure to the contaminated ground-water (for drinking water purposes) at any point between the Site and the LRC

- the shallow aquifer has not been used as drinking water source in the past and will not likely be used this purpose in the foreseeable future

- ground-water natural attenuation achieves cleanup standards within a time frame comparable to that of active aquifer restoration methods

STATUTORY DETERMINATION

Considering the new information that has been developed and the changes that have been made to the Selected Remedy, USEPA believes that the remedy remains protective of human health and the environment and complies with federal and state requirements that were identified in the June 1991 ROD as applicable or relevant and appropriate to this remedial action at the time the original ROD was signed. However, this remedy does not satisfy the statutory preference for treatment as a principle element because monitored natural attenuation was determined, by means of ground-water modeling, to restore the shallow aquifer beneath the Site in a time frame comparable to that of pump and treat.

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DECISION SUMMARY

1.0 SITE NAME, LOCATION, AND DESCRIPTION

1.1 Site Location

The Arlington Blending & Packaging Superfund Site (ABAP or Site) is located in the town of Arlington, Shelby County, Tennessee (Figure 1). The Site includes the 2.3 acre, former Arlington Blending & Packaging Company grounds and the areal extent of ground-water contamination.

The site is located at 12121 U.S. Highway 70 in a lightly developed, somewhat rural setting. A small residential area, known as the Mary Alice Drive Subdivision, is located adjacent to the eastern boundary of the Site.

1.2 Affected Population

The Mary Alice Drive subdivision, is located adjacent and due east of the Site property line. Approximately, 44 families reside within the subdivision. The subdivision is not located within the path of the contaminated ground water addressed in this ROD. Potable water is provided to the subdivision by the town of Arlington water department.

1.3 Adjacent Land Uses

The facility property is bordered on the south by CSX Railroad tracks; on the east by the Mary Alice Drive subdivision; on the north by a sod grass farm; and on the west by a Tennessee Department of Transportation facility. Currently, the portion of the Site where soil excavations took place is fenced on all sides with a locked gate to minimize trespassing.

1.4 Natural Resources

Ground water occurs beneath the Site, in significant yields, from about 20 to 45 feet below surface. Within this stratigraphic zone ground-water flows in a north to northwesterly direction towards the Loosahatchic River Canal (LRC). The shallow aquifer is contaminated with pesticides and volatile organics that resulted from former site operations. The next significant zone of water is encountered within the upper portion of the Memphis sand aquifer, located at approximately 115 to 125 below ground surface. An approximately 70 foot-thick sequence of confining clays and sandy clay is located between the shallow aquifer and the Memphis sand aquifer.

The nearest surface water body, the LRC, is located approximately 3,000 feet due north of the Site. The river is recognized by the State of Tennessee as being suitable for recreational purposes, wildlife, irrigation, and livestock watering.

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1.5 Site Operational History

From 1971 to 1978 the Arlington Blending & Packaging (ABAP) Company operated as a pesticide formulation and packaging facility (the Site). The ABAP Company blended technical grade pesticides with solvents and emulsifiers and packaged the products for their client companies, which were primarily pesticide manufacturers. During the company's operational period, spills and leakage of products handled there occurred, resulting in the soil and ground-water contamination that was addressed in the 1991 Record of Decision (ROD).

1.6 U.S. EPA Enforcement Summary

In October 1983 EPA conducted an immediate removal which consisted of the excavation of 1920 cubic yards of grossly contaminated surface soils (above 50 parts per million or ppm chlordane) and the removal and disposal of all equipment and waste chemicals present at the Site. These actions were taken to address surficial contamination that posed significant risk to human health.

The Site was proposed for inclusion on the National Priority List (NPL), as defined in Section 105 of CERCLA, as amended, 42 U.S.C. § 9605, in August 1986. It was finally listed as an NPL site on July 1987.

EPA completed its Remedial Investigation and Feasibility Study a (RI/FS) in January 1991. The RI detected pesticide contamination which included chlordane, heptachlor, endrin, pentachlorophenol (PCP), and arsenic in site soils. Contaminants such as pesticides, PCP, and 1,1-dichloroethene were detected in ground water above health based levels. Prior to undertaking the RI/FS, EPA formally requested, in January 1988, that the identified Potentially Responsible Parties (PRPs) do so voluntarily. The PRPs declined to conduct the RI/FS at that time.

The ROD was finalized in June 1991. In January 1992, EPA issued a Unilateral Administrative

Order (Section 106(a) of CERCLA, 42 U.S.C. § 9606(a)) to the site PRPs which ordered them to implement the 1991 ROD. The PRPs agreed to do so under the collective title of Arlington Blending Site Group (ABSG). The ABSG submitted the final Remedial Design Report, which addressed remediation of site soils, to EPA in January 1994.

In order to implement the soils remediation plan, it was necessary to issue an Explanation of Significant Differences (ESD) to the 1991 ROD to document significant changes to the soils remedy outlined in the ROD. Primarily, the ESD changed the maximum vertical excavation boundary to that of the water table and also limited the horizontal excavation boundary at the back of the Site to that of the railroad track.

Site soils remediation was conducted from January to July 1996 and consisted of the excavation and treatment of 41,431 tons of subsurface and surficial soils contaminated above 3.3 parts per million (ppm) chlordane, 0.6 ppm endrin, or 0.6 ppm pentachlorophenol.

1.7 Highlights of Community Participation

In accordance with CERCLA, Section 117 and NCP 300.435(c)(2)(ii) a revised proposed plan was mailed

to interested parties and other persons who have requested to be included on EPA's mailing list for the Site. The proposed plan supporting information was made available to the public in the information repository maintained at the EPA Docket Room in Atlanta and at the Arlington Public Library. Notice of availability of these documents was published in the Commercial Appeal on June 19, 1997. A comment period of thirty days was provided to receive written or oral comments from the public from June 18, 1997 to July 18, 1997. No comments were submitted to EPA regarding the amendment to the ROD.

2.0 REASONS FOR ISSUING THE ROD AMENDMENT

2.1 Description of the Original Selected Remedy

The original selected remedy (1991 ROD) contained both a soil and ground-water component.

The objective of the soil remediation was two fold; to excavate surficial soils that posed risk to humans as the result of dermal exposure or consumption and to excavate subsurface soils determined to be a source of ground-water contamination. The goal of the ground-water portion of the selected remedy was to restore contaminated ground water, contained in the site shallow aquifer, to drinking water quality.

The soils remediation was started in January 1996 and completed in July 1996. Thermal desorption was utilized to remove contaminants (primarily pesticides) from the soils by heating the soils in order to vaporize the contaminants into an off-gas stream. The volatilized contaminants were recovered by routing the off-gas stream through to a granulated activated carbon air pollution control system.

The 1991 ROD stated that contaminated ground water would be restored to drinking water quality by utilizing a series of ground-water wells to extract the identified ground-water contaminant plumes and treating the recovered water with granular activated carbon. Effluent from the carbon adsorption units was to be discharged to the to the town of Arlington Publicly Owned Treatment Works (POTW) facility or to the LRC. The ROD specified that Maximum Contaminant Levels (MCLs) under the Safe Drinking Water Act be established as cleanup standards for site ground water, reducing levels of benzene, chlordane, 1,1-dichloroethene (1,1-DCE), endrin, pentachlorophenol (PCP), and heptachlor epoxide to MCLs of 5.0 µg/ , 2.0 µg/ , 7.0 µg/ , 0.2 µg/ , 1.0 µg/ , and 1.0 µg/ , respectively. Only PCP, 1,1-DCE, and benzene have been detected in off-site monitoring wells. Note: µg/ is the same as ppb, parts per billion. The estimated extent of the PCP plume is presented in Figure 2.

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2.2 Rationale for Changing the Selected Remedy

In light of new site-specific data that has been obtained or developed since the 1991 ROD was finalized, EPA Region 4 now believes that monitored natural attenuation, rather than extraction, is the appropriate remedy for restoration of ground water contained in the Site's shallow aquifer. This approach will be fully protective of human health and the environment and will attain cleanup levels within a reasonable time frame.

There are no compelling factors that favor rapid restoration of the impacted shallow aquifer, since the aquifer ground water is not currently used for domestic purposes and will not realistically, be consumed in the future. Therefore, the fact that monitored natural attenuation may take longer to achieve ground water cleanup standards, than the most efficient pump-and-treat alternative, does not disqualify it as a remedial alternative.

In the 1991 ROD, the impacted shallow aquifer ground water was classified as IIB (pomential drinking water aquifer) primarily as the result of its non-saline characteristics and volumetric yield. This designation was supported by the lack of adequate site-specific data regarding the degree of hydraulic separation between the shallow aquifer ground water and the ground water in the Memphis sand aquifer (the primary source of potable water in the area). Therefore, EPA conservatively assumed that the surficial aquifer ground water potentially threatened the Class IIA ground water contained in the deeper Memphis sand aquifer. The absence of a confining layer would have increased the possibility that releases from the Site might adversely impact the Memphis sand aquifer, as the result of vertical leakage. EPA chose a pump-and-treat remedy as the means to actively restore the IIB shallow aquifer ground water to drinking water quality, in accordance with its Ground-Water Protection Strategy policy.

Since the original remedy was selected, the following information has been gathered to better characterize ground-water contamination in the shallow aquifer: (1) the shallow aquifer was determined to be hydraulically separated from the Memphis sand aquifer located below it; (2) the impacted ground water was determined to discharge into the Loosahatchie River Canal (LRC); (3) ground-water contaminant concentrations were determined to not adversely impact LRC surface water quality (i.e., do not exceed NPDES surface water discharge limits); (4) approximately 41,431 tons of contaminated source soils were excavated for treatment; (5) there are no downgradient receptors; and (6) existing Shelby County regulations prohibit construction of ground-water wells in proximity of the Site.

Additionally, EPA Region 4 conducted a ground-water modeling analysis in October 1996 to reevaluate the appropriateness of pump and treat as a means to achieve ground-water restoration following the 1996 site soil excavations. The analysis indicated that utilization of natural attenuation will attain ground-water cleanup within a reasonable time frame, compared to the cleanup time frame required by pump and treat, when biodegradation processes are considered. For instance, monitored natural attenuation was predicted to restore ground water to remediation levels within 28 years, while the two ground-water pump-and-treat alternatives evaluated for this ROD amendment attained cleanup levels within approximately 20 years (Appendix F).

The impacted shallow aquifer ground water poses no direct threat of future risk to lifetime residents and adult workers at the Site. The impacted shallow ground water poses no hydrogeological threat to water quality in the Memphis sand aquifer, nor to the LRC (Appendix E).

3.0 DESCRIPTION OF NEW ALTERNATIVES

Based upon consideration of the requirements of CERCLA, the NCP, and the detailed analysis of alternatives, EPA reviewed a total of four (4) ground-water restoration options for this ROD amendment to evaluate the feasibility of this option in light of new information that has been obtained since the original ROD was finalized.

Alternatives 1, 2, and 3 are variations of the original remedy, which stated that pump and treat would be utilized to restore ground water to levels protective of human health. The alternatives listed below were evaluated and compared to the nine critcria, as required by the NCP. EPA Region 4 has selected Alternative 4 as its preferred remedy which is estimated at $2,220,000 in present worth over thirty-five years. This response action will address the contaminated shallow ground water by allowing adsorption, biodegradation, dilution, and/or dispersion to effectively reduce contaminants to protective levels. Alternatives 1 and 2 involve employing on-site recovery wells to recover impacted ground water, but differ in the orientation of the off-site recovery wells. Alternative 3 involves limiting shallow ground-water extraction to on-site wells and does not address portions of the plume that have migrated off site.

Alternative 4 primarily consists of monitoring of contaminated ground water in the surficial aquifer beneath and adjacent to the Site and utilizing institutional controls to protect humans from exposure until protective levels are reached. An annual sampling of the city water supply for site contaminants of concern and a survey of wells constructed within a one mile radius of the Site will be required under this alternative. Also surface water sampling would be conducted in the threatened portion of the LRC in order to provide empirical assurance that stream water quality is not adversely impacted by the contaminant plume.

Remedial Alternative 1: Ground-Water Restoration using Both On-Property Recovery Wells and Off-Property Wells Oriented Parallel Path of Contaminant Plume Axis
Capital Cost: $1,533,600
Annual O&M Cost: $302,300
Present Worth: $7,739,400 (35 years at 4%)
Time to Construct: Less Than One Year

This alternative involves recovering impacted ground water using a series of extraction wells installed in the shallow aquifer. Each recovery well would be fitted with a submersible pump connected to a header pipe that discharges to a treatment system such as activated carbon adsorption columns. Treated water would be discharged to the LRC or Arlington POTW. An estimated four (4) extraction wells on site property and an estimated three (3) wells would be placed off-site across the sod farm property to the north. The off-site extraction wells would be oriented parallel to the path of the contaminant plume. An estimated five (5) wells would be installed to evaluate plume contaminant levels.

Annual sampling of ground water and report of the results would be conducted throughout the remediation period and for the five year period after remediation was completed.

Remedial Alternative 2: Ground-Water Restoration using Both On-Property Recovery Wells and Off-Property Wells Oriented Perpendicular to Path of Contaminant Plume Axis
Capital Cost; $2,028,200
Annual O&M Cost: $302,300
Present Worth: $8,798,100 (35 years at 4%)
Time to Construct: Less Than One Year

This alternative involves recovering impacted ground water using a series of extraction wells installed in the shallow aquifer. Each recovery well would be fitted with a submersible pump connected to a header pipe that discharges to a treatment system. Treated water would be discharged to the LRC or Arlington POTW. An estimated four (4) extraction wells on site property and an estimated eight (8) wells would be place off-site across the sod farm property to the north. The off-site extraction wells would be oriented, perpendicular to the path of the contaminant plume. An estimated five (5) wells would be installed to evaluate plume contaminant levels. Sampling and reporting procedures followed for this alternative would be the same as those described in Alternative 1.

Remedial Alternative 3: Ground-Water Restoration using On-Property Wells and Monitored Natural Attenuation of Off-site Plume
Capital Cost: $1,024,400
Annual O&M Cost: 302,260
Present Worth: $5,641,600 (35 years at 4%)
Time to Construct: Less Than One Year

This alternative involves recovering impacted ground water using a series of extraction wells installed in the site shallow aquifer. Each recovery well would be fitted with a submersible pump connected to a header pipe that discharges to a treatment system (i.e. activated carbon adsorption columns). Treated water would be discharged to the LRC or Arlington POTW. An estimated four (4) extraction wells would be installed on site property, with no off-site wells. An estimated five (5) wells would be installed to evaluate plume contaminant levels. Sampling and reporting procedures followed for this alternative would be the same as those described in Alternative 1.

Remedial Alternative 4: Monitored Natural Attenuation
Capital Cost: $21,600
Annual O&M Cost: $117,800
Present Worth: $2,220,000 (35 years at 4%)
Time to Construct: Less Than One Year

This alternative involves installing approximately five new monitoring wells at the Site to evaluate ground-water plume contaminant levels. Ground-water monitoring data would be reviewed annually to evaluate ground-water quality. The annual monitoring plan would include the following: (1) annual collection of water sample from city water supply for analysis; (2) annual well survey of wells installed within a 1-mile radius of the Site to identify wells installed since the previous survey; (3) annual sampling and analysis of LRC surface water; and (4) annual sampling and analysis of site monitoring well data.

4.0 COMPARATIVE ANALYSIS OF NEW ALTERNATIVE REMEDIES

USEPA Region 4 has reconsidered the Selected Remedy presented in the June 1991 ROD. This section profiles Alternative 4, which the Agency is now selecting, compared to the other alternatives that were evaluated, using the nine criteria.

THE ANALYSIS

Threshold Criteria

4.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Each of the ground-water recovery alternatives provides comparable protectiveness to human health and the environment. Since the shallow aquifer is hydraulically isolated from the Memphis sand aquifer located below it, contaminated ground-water flowing through the shallow aquifer poses no current risk or plausible future risk to those who utilize the Memphis sand aquifer for potable water.

A subsurface investigation of the geology beneath the sod farm was conducted in April 1996 to determine the lateral thickness and the vertical permeability of the clay confining unit above the Memphis sand aquifer. The investigation determined that the confining layer is uniformly contiguous beneath the property where the site plumes have migrated.

Further, existing county and State regulations prohibit the siting of domestic ground-water wells for a number of reasons, such as the availability of a publicly supplied water system proximity to a Superfund site, and flood plain construction restrictions. Thus, no reduction in carcinogenic risk is realized as the result of ground-water extraction measures relative to that of natural attenuation measures.

The surficial aquifer ground water was determined to discharge into the Loosahatchie River. The discharge poses no adverse impact to the river because ground-water contaminant levels are diluted below applicable ambient surface water levels.

4.2 Compliance with ARARs

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

The only ARARs for this Site are the maximum contaminant levels (MCLs), established under the Safe Water Drinking Act, for ground water that is, or may be used, for drinking. Each of the alternatives comply with ARARs since contaminant concentrations will be reduced below MCLs over time. Each of the

alternatives requires an extended period of time to achieve health based levels in downgradient monitoring wells. EPA's analysis of the each alternative's aquifer restoration time frame indicated that health-based levels could be achieved at compliance wells within comparable time frames of thirty years or less, when biodegradation was factored into estimated cleanup time assumptions.

The ground-water extraction systems described in Alternatives 1, 2, and 3 would primarily be subject to the state regulations that involve ground-water withdrawal and the discharge of treated water to the Loosahatchie River under state NPDES surface water discharge regulations or town Arlington POTW guidelines. Each of these alternatives would comply with the state's ground-water withdrawal and state NPDES requirements. The alternatives would also comply with applicable flood plain design and hazardous materials transportation requirements.

Primary Balancing Criteria

4.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refer to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

Alternatives 1, 2, and 3 would actively remove contaminants from impacted ground water and retard the migration of the site related contaminant, thereby permanently eliminating the potential for the recovered contaminants to threaten human health and the environment. All of the ground-water extraction alternatives should eventually provide a permanent remedy for ground water.

Alternative 4 does not actively reduce the level of contaminants in the site-related ground-water plumes. Rather, it relies on natural processes (i.e., biodegradation, dilution, dispersion, adsorption, and chemical degradation) to reduce contaminant concentrations. However, the impacted shallow aquifer containing the plumes has not in the recent past, currently, or will not in the foreseeable future be used for domestic purposes.

The impacted ground-water poses no risk to human health as the result of ingestion. The shallow aquifer discharges into the Loosahatchie River Canal (LRC) which is located approximately 3000 feet downgradient of the Site. Ground-water contaminants discharged to the LRC would be diluted to below applicable ambient water quality levels for Tennessee surface waters. Additional monitoring wells would be installed to monitor plume contaminant levels for increases that may adversely impact the LRC.

4.4 Reduction of Toxicity, Mobility or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at a site.

Alternatives 1 and 2 involve extraction of contaminant plume both onsite and off site, while Atternative 3 would limit ground-water extraction to on-site wells. Alternative 3 would employ monitoring wells within the path of the off-site plume.

Alternative 4 will not actively reduce the mobility, toxicity, or volume of the site-related ground-water plumes, even though ground-water restoration eventually is predicted as the result of natural attenuation.

This alternative will incorporate regular monitoring to gauge the progress of plume contaminant levels compared to site performance standards. Constituent concentrations within the plumes are expected to decrease with time, since more than 90 percent of the contaminated source soils have been removed.

Alternatives 1, 2, 3, and 4 are predicted to attain remidiation levels within 21 years, 19 years, 29 years, and 28 years, respectively.

4.5 Short-Term Effectiveness

Short-term effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy.

Construction activities associated with Alternatives 3 and 4 would be limited to the Site, while Alternatives land 2 would involve construction on the sod farm property. As a result, there should be no adverse effects to the community. Short-term effects to on-site workers involved in the construction should be minimal. However, health and safety procedures will be implemented during the construction as a precaution. The time required for implementation of these alternatives is expected to be less than one year. There are no short term threats associated with the Selected Remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the remedy.

4.6 Implementability

Treatment equipment associated with Alternatives 1, 2, and 3 is readily available from multiple vendors. Similarly, the installation of additional monitoring wells, extraction wells, and related piping, can be accomplished easily for each of the alternatives.

4.7 Cost

A comparison of present worth costs associated with the ground water alternatives indicates that Alternative 4 is the least expensive ($2,219,920), followed by Alternative 3 ($6,666,000), followed by Alternative 1 ($7,739,350) and Alternative 2 ($7,798,100). Capital costs will be much higher for Alternative 2 ($2,028,200) compared to Alternatives 1, 3, and 4 ($1,533,600, $1,024,420 and $21,600, respectively). Annual O&M costs will be approximately equal for Alternatives 1, 2, and 3 ($302,260 and considerably less for Alternative 4 at $177,800.

MODIFYING CRITERIA

4.8 State Acceptance

The State of Tennessee concurs with this amendment to the 1991 ROD. The State's reasoning focused on the recent source removals and confirmation of an existing confining layer beneath the Site and ground water as the basis for their concurrence. See Appendix A.

4.9 Community Acceptance

No public comment was submitted to EPA regarding the ROD Amendment.

5.0 STATUTORY DETERMINATIONS

Under its legal authorities, EPA's primary responsibility at Superfund sites is to select remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA established several other statutory requirements and preferences. These specify that when complete, the selected remedial action for a site must comply with applicable or relevant and appropriate envirorimental standards established under Federal and State environmental laws unless a statutory waiver is granted. The selected remedy must also be cost-effective and utilize permanent treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that permanently and significantly reduce the volume, toxicity, or mobility or hazardous wastes.

Considering the new information that has been developed and the changes that have been made to the selected remedy, USEPA believes that the remedy remains protective of human health and the environment, complies with federal and state requirements that were identified in the June 1991 ROD as applicable or relevant and appropriate to this remedial action. In addition, the revised remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site.

APPENDIX A

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APPENDIX A

State of Tennessee Concurrence Letter

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STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Superfund
401 Church Street
4th Floor, L&C Annex
Nashville, TN 37243-1538

May 22,1997

Mr. Derek Matory
Environmental Project Manager
United States Environmental Protection Agency
Region 4
Atlanta Federal Center
100 Alabama Street, S.W.
Atlanta, Georgia 30303-3104

Re: Concurrence for the Amended Record of Decision Proposed Plan for the Arlington Blending &
Packaging site, Arlington, Shelby County, Tennessee, June 1997, TDSF #79-503

Dear Mr. Matory:

The Tennessee Division of Superfund (TDSF) has reviewed the draft Amended Record of Decision

Proposed Plan for the Arlington Blending & Packaging site, Arlington, Shelby County, Tennessee, dated June 1997, sent under cover on 5/8/97.

The Tennessee Department of Environment and Conservation (TDEC) is in concurrence with the amended remedy, Alternative 4, Monitored Natural Attenuation. New information has been provided regarding the subsurface transport mechanisms, in particular confirmation of the existence of a substantial confining unit beneath the Site and groundwater. Source removals conducted at the Site in Operable Unit 1 have also served to significantly diminish source contribution to the groundwater plume. Time frames for Natural Attenuation, although longer than pump and treat scenarios, are generally within the same order of magnitude. Factors included in the concurrence with this alternative included: short term risks, cost, and local enterprise impacts.

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APPENDIX B

59 0028

APPENDIX B

Summary of Cost Estimates for Evaluated Alternatives

<IMG 97183A6>

ARINGTON BLENDING SITE
Groundwater Treatment System
Revision of Cost Estimate Provided by BCM

Item Description	Quantity	Units	Material Cost ($/unit)	Installation cost ($/unit)	Total Installation Cost	Total Cost
Treatment Plant						
Groundwater Collection Tank	1	Each	$ 4,000	$ 1,000	$ 5,000	$ 5,000
Dynasand Filter with Carbon	1	Each	62,000	20,000	82,000	82,000
Polishing Carbon Filter	1	Each	5,000	3,000	8,000	8,000
Compressor	1	Each	3,500	1,000	4,500	4,500
Bag Filter	1	Each	2,000	1,000	3,000	3,000
Effluent Tank	1	Each	4,000	1,000	5,000	5,000
Backwash Tank w/agitation	1	Each	5,000	1,000	6,000	6,000
Pumps	6	Each	1,000	300	1,300	7,800
Control Panel	1	Each	10,000	5,000	15,000	15,000
Instrumentation	1	Each	70,000	20,000	90,000	90,000
Control Software	1	Each	6,000	200	6,200	6,200
Control PC	1	Each	2,500	200	2,700	2,700
Control Software Programming	1	Each	15,000	-	15,000	15,000
Piping	1	Each	40,000	15,000	55,000	55,000
					Treatment Plant Subtotal	305,200
Ancillary Systems						
Electrical	1	Each	20,000	15,000	35,000	35,000
Treatment Building (40'x30')	1,200	Sq.Ft.	28	28	56	67,200
Pad Improvements + Foundation	1	Each	20,000	20,000		

40,000 40,000

Ancillary Systems

Subtotal 142,200

Subtotal 447,400

2% Allowance for Contractor Bonding and Insurance 8,948

3% Allowance for Mob./Demob. 13,422

Subtotal 469,770

20% Allowance for Engineering, Legal and Construction Services 93,954

Subtotal 563,724

Contingency 20% 169,117

Commissioning and startup 30,000

Estimated Total Treatment Plant Cost $ 762,841

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Item Description	Quantity	Units	Material Cost ($/unit)	Installation cost ($/unit)	Total Installation Cost	Total Cost
Monitoring System Well Installation	6	Each	2,500	-	2,500	15,000

Subtotal 15,000

20% Allowance for Engineering and Construction Services 3,000

Subtotal 18,000

Contingency 20%	3,600
Total Monitoring System	$ 21,600

O&M (no treatment)

ARLINGTON BLENDING SITE
Intrinsic Remediation
Projected Annual O&M Costs

Item	Quantity	Usage Rate	Operating Schedule	Unit cost	Annual Cost	Total Annual Cost
Labor Requirements						
Sampling Technician - wells	1	8 hour/day	10 day/year	$40/hour	$ 3,200	
Subtotal Labor						$ 3,200
Analytical						
GW chemical monitoring						
VOC's	18	1 sample/year	1 sample/year	185	3,330	
BNA's	18	1 sample/year	1 sample/year	375	6,750	
Pesticides	18	1 sample/year	1 sample/year	150	2,700	
Metals (As)	18	1 sample/year	1 sample/year	50	900	
Inorganics	18	1 sample/year	1 sample/year	200	3,600	
Subtotal Analytical						17,280
Engineering and Management						
Oversight	1	8 hour/day	30 days/year	90	21,600	
Engineering (data + reports)	1	8 hour/day	60 days/year	90		

Item	Quantity	Usage Rate	Operating Schedule	Unit cost	Annual Cost	Total Annual Cost
					43,200	
Subtotal Engineering and Management						64,800
EPA Oversight	1	1 /year	1 /year	20,000	20,000	
Subtotal EPA Oversight						20,000
Utilities						
Electricity	1	1 /year	1 /year	1,000	1,000	
Water	1	1 /year	1 /year	500	500	
Phone	1	1 /year	1 /year	1,000	1,000	
Subtotal Utilities						2,500
Maintenance	1	1 /year	1 /year	10,000	10,000	
Subtotal Maintenance						10,000
Site Maintenance						
Fertilizing	1		4 times/year	1,000	4,000	
Mowing	1		8 times/year	500	4,000	
Subtotal Site Maintenance						8,000
Total Annual O&M Estimated Cost						$ 117,780

ARLINGTON BLENDING SITE
Groundwater Treatment System
Projected Annual O&M Costs

Item	Quantity	Usage Rate	Operating Schedule	Unit cost	Annual Cost	Total Annual Cost
Labor Requirements						
System Operator	1	8 hour/day	365 days/year	$20/hour	$ 58,400	
Sampling Technician - plant	1	8 hour/day	1 day/month	40/hour		

					3,840
Sampling Technician - wells	1	8 hour/day	4 day/year	40/hour	1,280
				Subtotal Labor	$ 63,520
Analytical					
GW chemical monitoring					
VOC's	18	1 sample/year	1 sample/year	185	3,330
BNA's	18	1 sample/year	1 sample/year	375	6,750
Pesticides	18	1 sample/year	1 sample/year	150	2,700
Metals (As)	18	1 sample/year	1 sample/year	50	900
Inorganics	18	1 sample/year	1 sample/year	200	3,600
				Subtotal	17,280
System Monitoring					
VOC's	5	1 sample/quarter	4 quarters/year	185	3,700
BNA's	5	1 sample/quarter	4 quarters/year	375	7,500
Pesticides	5	1 sample/quarter	4 quarters/year	150	3,000
Metals (As)	5	1 sample/quarter	4 quarters/year	50	1,000
Inorganics	5	1 sample/quarter	4 quarters/year	200	4,000
				Subtotal	19,200
				Subtotal Analytical	36,480
Engineering and Management					
Oversight	1	8 hour/day	48 days/year	90	34,560
Engineering (data + reports)	1	8 hour/day	45 days/year	90	32,400
				Subtotal Engineering and Management	66,960
EPA Oversight	1	1 /year	1 /year	20,000	20,000
				Subtotal EPA Oversight	20,000
Utilities					
Electricity	1	1 /year	1 /year	24,000	24,000
Water	1	1 /year	1 /year	2,000	2,000
Phone	1	1 /year	1 /year	2,000	2,000
				Subtotal Utilities	28,000
Supplies					
Activated Carbon	1		2 changes/year	15,000	

30,000
Filters and disposal 1 1 /day 365 days/year 20
7,300
Subtotal Supplies
37,300

Maintenance 1 1 /year 1 /year $50,000 $
50,000
Subtotal Maintenance
50,000

Total Annual O&M Estimated Cost
$ 302,260

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Arlington Blending Site
Groundwater Treatment System
Revision of Cost Estimate Provided by BCM

Item Description	Quantity	Units	Material Cost ($/unit)	Installation Cost ($/unit)	Total Installation Cost	Total Cost
Treatment Plant						
Groundwater Collection Tank	1	Ea.	$4,000	$1,000	$5,000	$5,000
Dynasand Filter with Carbon	1	Ea.	$62,000	$20,000	$82,000	$82,000
Polishing Carbon Filter	1	Ea.	$5,000	$3,000	$8,000	$8,000
Compressor	1	Ea.	$3,500	$1,000	$4,500	$4,500
Bag Filter	1	Ea.	$2,000	$1,000	$3,000	$3,000
Effluent Tank	1	Ea.	$4,000	$1,000	$5,000	$5,000
Backwash Tank w/agitation	1	Ea.	$5,000	$1,000	$6,000	$6,000
Pumps	6	Ea.	$1,000	$300	$1,300	$7,800
Control Panel	1	Ea.	$10,000	$5,000	$16,000	$15,000
Instrumentation	1	Ea.	$70,000	$20,000	$90,000	$90,000
Control Software	1	Ea.	$6,000	$200	$6,200	$6,200
Control PC	1	Ea.	$2,500	$200	$2,700	$2,700
Control Software Programming	1	Ea.	$15,000	$0	$15,000	$15,000

Piping	1	Ea.	$40,000	$15,000	$55,000	$55,000
					Treatment Plant Subtotal	$305,200
Ancillary Systems						
Electrical	1	Ea.	$20,000	$15,000	$35,000	$35,000
Treatment Building (40'x30')	1200	Sq. Ft.	$28	$28	$56	$67,200
Pad Improvements + Foundation	1	Ea.	$20,000	$20,000	$40,000	$40,000
					Ancillary Systems Subtotal	$142,000
					Subtotal	$447,400
					2% Allowance for Contractor Bonding and Insurance	$8,948
					3% Allowance for Mob./Demob.	$13,422
					Subtotal	$469,770
					20% Allowance for Engineering, legal and Construction Services	$93,954
					Subtotal	$563,724
					Contingency 20%	$169,117
					Commissioning and startup	$30,000
					Estimated Total Treatment Plant Cost	$762,841

Extraction System (on Property)						
Collection Pipe (2"/3" HOPE)	750	L.F.	$25	$0	$25	$18,750
Discharge Pipe (1 1/2"/3" HDPE)	3230	L.F.	$30	$0	$30	$96,900
Well Installation	4	Ea.	$5,000	$0	$5,000	$20,000
Well Pump	4	Ea.	$2,000	$0	$2,000	$8,000
Valve box	4	Ea.	$4,000	$0	$4,000	$16,000
Electrical	700	L.F.	$10	$0	$10	$7,000
					Subtotal	$166,660

20% Allowance for Engineering, legal and Construction Service						$33,330
Subtotal						$199,980
Contingency 20%						$39,996
Total Extraction System (On-Property)						$239,976
Extraction System (off Property)						
Collection Pipe (2"/3" HOPE)	3000	L.F.	$30	$0	$30	$90,000
Discharge Pipe (increase to 4"/6")	3230	L.F.	$40	$0	$40	$129,200
Highway Tunneling	50	L.F.	$300	$0	$300	$15,000
Well Installation	3	Ea.	$5,000	$0	$5,000	$15,000
Well Pump	3	Ea.	$2,000	$0	$2,000	$6,000
Valve box	3	Ea.	$4,000	$0	$4,000	$12,000
Electrical	3000	L.F.	$10	$0	$10	$30,000
Subtotal						$297,200
20% Allowance for Engineering, legal and Construction Services						$59,440
Subtotal						$297,200
Contingency 20%						$59,440
Total Extraction System (Off-Property)						$356,640
Monitoring System						
Well Installation	6	Ea.	$2,500	$0	$2,500	$15,000
Subtotal						$15,000
20% Allowance for Engineering and Construction Services						$3,000
Subtotal						$18,000
Contingency 20%						$3,600
Total Monitoring System						$21,600

Arlington Blending Site
Groundwater Treatment System
Projected Annual O&M Costs

Item	Quantity	Usage Rate	Operating Schedule	Unit Cost	Annual Cost	Total Annual Cost
Labor Requirements						
System Operator	1	8 hr/day	365 days/yr.	$20/hr	$58,400	
Sampling Technician - plant	1	8 hr/day	1 day/mo.	$40/hr	$3,840	
Sampling Technician - wells	1	8 hr/day	4 day/yr	$40/hr	$1,280	
			Subtotal Labor			$63,520
Analytical						
GW chemical monitoring						
VOC's	18	1 sample/yr	1 sample/yr	$185	$3,330	
BNA's	18	1 sample/yr	1 sample/yr	$375	$6,750	
Pesticides	18	1 sample/yr	1 sample/yr	$150	$2,700	
Metals (As)	18	1 sample/yr	1 sample/yr	$50	$900	
Inorganics	18	1 sample/yr	1 sample/yr	$200	$3,600	
			Subtotal		$17,280	
System Monitoring						
VOC's	5	1 sample/qtr	4 qtrs/yr	$185	$3,700	
BNA's	5	1 sample/qtr	4 qtrs/yr	$375	$7,500	
Pesticides	5	1 sample/qtr	4 qtrs/yr	$150	$3,000	
Metals (As)	5	1 sample/qtr	4 qtrs/yr	$50	$1,000	
Inorganics	5	1 sample/qtr	4 qtrs/yr	$200	$4,000	
			Subtotal		$19,200	
			Subtotal Analytical			$36,480
Engineering and Management						
Oversight	1	8 hr/day	48 days/yr	$90	$34,560	
Engineering (data + reports)	1	8 hr/day	45 days/yr	$90	$32,400	
		Subtotal Engineering and Management				$66,960
EPA Oversight	1	1/yr	1/yr	$20,000	$20,000	
			Subtotal EPA Oversight			$20,000
Utilities						
Electricity	1	1/yr	1/yr	$24,000	$24,000	
Water	1	1/yr	1/yr	$2,000	$2,000	
Phone	1	1/yr	1/yr	$2,000	$2,000	
			Subtotal Utilities			$28,000
Supplies						
Activated Carbon	1		2 changes/yr	$15,000	$30,000	
Filters and disposal	1	1/day	365 days/yr	$20	$7,300	
			Subtotal Supplies			$37,300
Maintenance	1	1/yr	1/yr	$50,000	$50,000	
			Subtotal Maintenance			$50,000
			Total Annual O&M Estimated Cost			$302,260

O&M (no treatment)

Arlington Blending Site
Intrinsic Remediation
Projected Annual O&M Costs

Item	Quantity	Usage Rate	Operating Schedule	Unit Cost	Annual Cost	Total Annual Cost
Labor Requirements						
Sampling Technician - wells	1	8 hr/day	10 day/yr	$40/hr	$3200	
			Subtotal Labor			$3,200
Analytical						
GW chemical monitoring						
VOC's	18	1 sample/yr	1 sample/yr	$185	$3,330	
BNA's	18	1 sample/yr	1 sample/yr	$375	$6,750	
Pesticides	18	1 sample/yr	1 sample/yr	$150	$2,700	
Metals (As)	18	1 sample/yr	1 sample/yr	$50	$900	
Inorganics	18	1 sample/yr	1 sample/yr	$200	$3,600	
			Subtotal Analytical			$17,280
Engineering and Management						
Oversight	1	8 hr/day	30 days/yr	$90	$21,600	
Engineering (data + reports)	1	8 hr/day	60 days/yr	$90	$43,200	
		Subtotal Engineering and Management				$64,800
EPA Oversight	1	1/yr	1/yr	$20,000	$20,000	
			Subtotal EPA Oversight			$20,000
Utilities						
Electricity	1	1/yr	1/yr	$1,000	$1,000	
Water	1	1/yr	1/yr	$500	$500	
Phone	1	1/yr	1/yr	$1,000	$1,000	
			Subtotal Utilities			$2,500
Maintenance	1	1/yr	1/yr	$10,000	$10,000	
			Subtotal Maintenance			$10,000
Site Maintenance						
Fertilizing	1		4 times/yr	$1,000	$4,000	
Mowing	1		8 times/yr	$500	$4,000	
			Subtotal Site Maintenance			$8,000
			Total Annual O&M Estimated Cost			$117,780

APPENDIX C

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APPENDIX C

Estimated Mass of PCP Contaminated Soils Remaining After Soil Excavations

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Table 5-4. Summary of Estimated Contaminant Removals

Contaminant	(a) Mass Processed (lb)	(b) Mass Left in Place Excavations (lb)	At Railroad (lb)	(c) Removal (wt%)
Chlordane	1,772	62	85	92.3
Heptachlor	394	16	77	80.9
Endrin	355	4	9	96.5
Heptachlor Epoxide	173	0.7	1.0	99.0
Pentachlorophenol (d)	63	5	(e)	92.7
Total COC's	2,757	88	172	91.4

Notes:

a) Estimated mass of contaminant in soil excavated and thermally treated.

b) Estimated mass of contaminant remaining in soil not excavated. Values assume that remaining soils are contaminated at the final measured concentration for an additional 2 feet. See Appendix I for a list of assumptions and an example calculation. Values for mass left in place at the

railroad track
are biased high by sample SW-0220964/J04 (see Table 4-6).

c) (Mass Processed) x 100/(Mass Processed + Mass Left in Place)

d) Estimates obtained from calculations by Memphis Environmental Center, Inc. (MEC).

e) Mass left in place calculated by MEC includes pentachlorophenol left at railroad tracks.

APPENDIX I

Calculations of Contaminant Removals

$$R = \frac{(MP)(100)}{(MP + ML)}$$

$$MP = \frac{(CA)(T)(F1)}{(1,000,000,000)}$$

$$ML = MLi$$

$$MLi = \frac{(Ci)(Si)}{(F2)}$$

$$Si = (Vi)(BD)(F1)$$

$$Vi = \frac{(L)(W)(D)}{(F3)}$$

Where: R = Contaminant Removal (%)
MP = Mass of Contaminant Processed (lb)
ML = Mass of Contaminant Left in Place (lb)
CA = Average Contaminant Concentration in Soil Thermally Processed (μg/kg)
T = Mass of Soil Excavated and Thermally Processed (41,431 tons)
F1 = Conversion Factor (2,000 lbs/ton)
F2 = Conversion Factor (1,000,000,000 μg/kg)
MLi = Mass of Contaminant left in the ith Grid (lb)
Ci = Contaminant Concentration in Final Sample of ith Grid (μg/kg)
Si = Mass of Soil in ith Grid (lb)
Vi = Volume of Soil in ith Grid (yd 3)
BD = In-situ Bulk Density of Soil (1.6 ton/yd 3)
L = Length of ith Grid (ft)
W = Width of ith Grid (ft)
D = Depth of ith Grid (ft)
F3 = Conversion Factor (27 ft 3/yd 3)

Mass of Contaminant Processed

Assumptions:

1. The concentration of contaminants in the total mass of soil processed is represented by the average contaminant concentration from all samples taken during the remedial action.

2. Samples determined to be nondetect for a contaminant are assumed to be contaminated at the detection limit.

Example:

Using the above assumptions for Chlordane the average concentration (CA) of chlordane in the mass of soil processed is 21,390 µg/kg, then;

$$MP = \frac{21{,}390\ \mu g/kg)(41{,}431\ tons)(2{,}000\ lbs/ton)}{(1{,}000{,}000{,}000\ \mu g/kg)} = 1{,}772 \text{ lbs of chlordane}$$

Mass of Contaminant Left in Place

Assumptions:

1. Each final sample in excavated grids is representative of a 25 x 25 foot grid.

2. Each final sample from the side walls of the railroad track is representative of a 50 x 20 foot area.

3. Contamination exists in each grid to a depth of 2 feet at the concentration in the final sample taken in the grid.

Example:

Using the above assumptions in Grid M10 where the final chlordane concentration was measured to be 8,360 µg/kg, the mass of chlordane left in place at Grid M10 is:

$$ML10 = \frac{(8{,}360\ \mu g/kg)(S10\ lb)}{1{,}000{,}000{,}000\ \mu g/kg}$$

$$S10 = (V10\ yd\ 3)(1.6\ ton/yd\ 3)(2{,}000\ lbs/ton)$$

$$V10 = \frac{(25\ ft)(25\ ft)(2\ ft)}{(27\ ft\ 3/yd\ 3)} = 46.3\ yd\ 3$$

$$S10 = (46.3\ yd\ 3)(1.6\ ton/yd\ 3)(2{,}000\ lb/ton) = 148{,}148\ lb$$

$$ML10 = \frac{(8{,}360\ \mu g/kg)(148{,}148\ lb)}{(1{,}000{,}000{,}000\ \mu g/kg)} = 1.2 \text{ lb of chlordane}$$

Continuing this process for each grid and the soils left at the railroad track and summing generates an estimate of the total mass of chlordane left in place of:

$$ML = 62 \text{ (in excavations)} + 85 \text{ (at the railroad)} = 147 \text{ lb}$$

$$R = \frac{(1{,}772)(100)}{(1{,}772 + 147)} = 92.3\%$$

See Table 5-4 in ft report for a summary of the results for all organic contaminants of concern.

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APPENDIX D

5 9 0042

APPENDIX D

Local Ordinances Regarding Well Installation and Water Withdrawal

In addition, the results are based the highest average groundwater concentration detected at the Site for each contaminant as presented in EPA's modeling study (EPA's Review of "Groundwater Modeling Effort to Evaluate Remedial Alternatives for Contaminated Groundwater at the Arlington Blending and Packaging Site," October 17, 1996). These are concentrations likely never to discharge to the river. Much lower concentrations of the contaminants of concern will most likely discharge to the Loosahatchie River. It is anticipated that contaminants will, degrade during migration in the surficial aquifer due to a number of transport phenomena such as biodegradation, dispersion, and dilution due to recharge. Off-property groundwater analytical results are consistent with this theory. For example, the highest off-property groundwater PCP concentration to date is 325 µg/l in off-property well AB-9D. In addition, a plume discharge width of 400 feet is conservative. Based on groundwater analytical data, the plume discharge width at the river may be over a river length on the order of tens of feet as opposed to hundreds of feet. In any event, the highest average groundwater concentration discharging over the entire plume discharge width is very unlikely.

Table 1 - The Results of the Surface Water Dilution Calculation

Compound	Maximum Concentration mg/l	Dilution Calculation Results mg/l	Human Recreation Regulatory Limit (a) mg/l	Aquatic Regulatory Limit (b) mg/l
PCP	1.106	0.0005	0.0028	0.013
1,1-DCE	0.0273	0.00001	0.0005	0.00057
Benzene	0.0504	0.00002	0.0012	0.012

(a) - Human Recreation regulatory limits based on TDEC's Division of Water Pollution Control Criteria
(b) - Aquatic regulatory limits based on TDEC's Division of Water Pollution Control Criteria (Division of Water Pollution Control Regulations, Chapter 1200-4-3 - General Water Quality Criteria).

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(2) Surficial aquifer groundwater discharge to the Loosahatchie River.

As noted on page 6 in the Groundwater Modeling Report, surficial aquifer groundwater flows north-northwest across the Site and discharges to the Loosahatchie River. This information was based on site-specific groundwater head measurements, general hydrogeology of the area, and the EPA's Final Remedial Investigation Report (Final Remedial Investigation Report: - Volume I RI Report Text, Arlington Blending and Packaging Site, November 1990). Specifically, Section 5.2 - Surface Water/Sediment Contaminant Fate and Transport and Section 5.2.1 - Surface Water/Sediment Contamination from Ground-water Discharge (page 134) of the EPA's 1990 report discuss discharge of the surficial aquifer groundwater to the Loosahatchie River.

Although Loosahatchie River flow measurements are not available upstream and downstream of the Site to quantify the rate of groundwater discharge to the river near the Site, it is believed that all surficial aquifer groundwater discharges to the river year-round. This information is consistent with your conversation on Friday February 7, 1997 with the USGS (Mr. Larry B. Thomas of the USGS Water Resources Division, Memphis, TN). The USGS considers the Loosahatchie River near the Site to be a gaining stream year-round. Furthermore, they consider the River's base flow to be fully supported by discharge from shallow aquifers, including the surficial aquifer at the Site.

Attachments
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[29.] WATER

Water Control Board ....Ch. 497, Pvt. 1949
Water Quality Control ....Ch. 167, Pvt. 1973

PRIVATE ACTS, 1949, CHAPTER 497.

An Act to authorize the county of Shelby in connection and in conjunction with the City of Memphis to establish a Board to be called the Memphis and Shelby County Board of Water Control, with powers to regulate, limit and prohibit the drilling of wells in Memphis and Shelby County; to regulate the exploitation and consumption of artesian water under the land in said City and County; otherwise defining the powers and duties of said Board; defining the qualifications of the members; fixing their terms of office, and their procedure.

[29-1] SECTION 1. Be it enacted by the General Assembly of the State of Tennessee, That whereas the water supply of the City of Memphis, Shelby County, Tennessee, is obtained from artesian wells operated by the Light, Gas and Water Division of the City of Memphis, said water supply being furnished by the said Light, Gas and Water Division of the City of Memphis not only to citizens of the City of Memphis, but to the citizens of certain portions of Shelby County outside of the said City of Memphis; and

WHEREAS, the water supply of other citizens in Shelby County, outside the City of Memphis, is obtained by them by means of private artesian wells; and

WHEREAS, many large industries in the City of Memphis and its environs operate private wells, which contribute to the exhaustion of the said subterranean water supply, year by year lowering the level of the said subterranean waters and tending to endanger the pure water supply available to the citizens of the City of Memphis and Shelby County; and

WHEREAS, the maintenance of a plentiful subterranean water supply for the thickly populated urban area in and

RULES AND REGULATIONS OF WELLS
IN
SHELBY COUNTY

PURSUANT TO THE AUTHORITY GIVEN IN THE ORDINANCES OF SHELBY COUNTY AND THE MUNICIPALITIES THEREIN WHICH ESTABLISHED THE GROUND WATER QUALITY CONTROL BOARD FOR SHELBY COUNTY; TO ESTABLISH INSPECTION AND PERMIT FEES; TO CONTROL AND REGULATE THE LOCATION, CONSTRUCTION, AND MODIFICATION OF ALL TYPES OF WELLS IN SHELBY COUNTY; AND TO PROVIDE PENALTIES FOR THE VIOLATION THEREOF.

SECTION 1 -- GENERAL PROVISIONS

1.01 -- Statutory Authority

The Ground Water Quality Control Board for Shelby County establishes and adopts the following regulations in accordance with the authority granted by the ordinances of Shelby County and the municipalities therein which established the Ground Water Quality Control Board for Shelby County:

1.02 -- Scope and Applicability

A. Minimum requirements are hereby prescribed in these Rules and Regulations governing the location, design, installation, use, disinfectation, modification, repair and abandonment of water wells and associated pumping equipment, or any other type of well. No person shall conduct any activity contrary to the provisions of these regulations, and all such activities which are contracted for shall be carried out only by those persons having a valid Tennessee License for Water Well Drillers, and Pump Installers and/or those engineers or geologists registered in the State of Tennessee. These regulations supersede all other well construction regulations.

B. These regulations apply to well construction activities from the initial penetration or excavation of the ground, through development, modification, equipment installation, repair and disinfection. Set up of construction equipment before actual penetration or excavation is not considered part of the construction.

C. The regulations apply to the construction activities of any and all types of wells.

Pages 2 - 8 intentionally left out

3.56 -- Well Logs: A record of geologic formations penetrated in drilling a water well, monitoring, recovery, dewatering, observation or any other type of well; or any boring into the subsurface thirty (30) feet or deeper.

Section 4 GENERAL REQUIREMENTS AND PROCEDURES

4.01 -- Applications

A. Any person requesting the installation, modification, repair, or abandonment of a water well or any other type well shall make application to the Department.

B. All applications requesting new well installation or the modification of an existing well shall be accompanied by a plot plan showing the location of all underground utilities within fifty (50) feet of the proposed well; grade elevations in relation to adjoining areas and drainage patterns of the area; location of the residence, business, etc.; locations of septic tanks and field lines when applicable; other existing and proposed buildings and structures; any water service lines that may exist on the premises; any drainage ditches, lakes, ponds, streams, etc., that may exist at the premise; any roads or dedicated right-of-ways or easements; and any other pertinent information deemed necessary by the Department. The application shall also include a sketch of how the well is to be constructed.

C. A water well cannot be sited or placed in service within a half-mile of the designated boundaries of a listed federal or State Superfund site or Resource Conservation and Recovery Act corrective action, site, unless the well owner can make a demonstration that the well will not enhance the movement of contaminated, groundwater or materials into the shallow or deep aquifer.

D. An application may be obtained from the Department, and if approved, such application shall be in force and in effect for ninety (90) days from the date of its issuance. If work has not commenced within ninety (90) days of issuance, an extension may be granted by the Department upon request by the applicant.

E. A processing fee shall be submitted with all

Pages 10 - 12 intentionally left out

applicable laws and regulations.

D. It shall be the well driller's duty to inform persons requesting the services of his company, to construct, repair, alter, modify, or to perform any other service related to a well of the requirements of these Rules and Regulations.

E. The well driller shall be held liable for any type of well work initiated prior to the Department issuing a written permit.

F. It shall be the duty of the well driller to notify the Department when construction on a well is to begin and when the work is completed so that proper inspections can be made during and after construction, and for the purpose of collecting samples from production wells.

G. The well driller shall notify the Department when repair or modification work, as directed within these Rules and Regulations, is done on a well.

H. Within thirty (30) days after a well has been constructed or modified, the well driller shall submit a report of construction (well log) to the Department on such forms as are prescribed or which may be furnished by the Department.

I. The well driller shall notify the Department prior to beginning abandonment procedures on a well.

Section 5 -- WELL CONSTRUCTION STANDARDS FOR WATER WELL

5.01 -- General

A. All wells shall be constructed in a manner that will guard against waste and contamination of the groundwater aquifers underlying Memphis and Shelby County. No person shall construct, repair, modify, or abandon or cause to be constructed, repaired, modified, or abandoned any well contrary to the provisions of these Rules and Regulations.

5.02 -- Siting Criteria

A proposed well location shall satisfy the following minimum horizontal separation distance requirements:

1. Fifty (50) feet from a property line, to allow access to the well without encroaching on adjoining properties; to provide adequate

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D. All parcels of land requiring a well for a source of potable water shall be self-supporting in that sharing a water supply shall not be allowed. A water line shall not cross property boundaries for the purpose of providing potable water to a premise on a permanent basis.

E. A well cannot be sited or placed in service within a half-mile of the designated boundaries of a listed federal or State Superfund site or Resource Conservation and Recovery Act corrective action site, unless the well owner can make a demonstration that the well will not enhance the movement of contaminated groundwater or materials into the shallow or deep aquifer.

5.03 -- Sanitary Protection of Wells

A. All water used in the construction of a well shall be from an approved potable water supply. Water obtained from lakes, ponds, streams, and other such surface water sources is not approved and shall not be used in the well construction process.

B. It shall be the responsibility of the well driller to protect the opening made in drilling the well against any foreign material or any other type of contamination from entering the opening.

C. In the event a well becomes contaminated or obstructed, the well driller shall take whatever measures necessary to clear the well of contamination or obstruction. Should he decide to abandon the well for any reason, the well shall be filled in a manner prescribed by Section 9 of these Rules and Regulations.

D. Whenever construction stops before the well is grouted and pumping equipment is installed, the open annular space shall be covered and the well casing capped. The cap shall be either threaded onto the casing secured by a friction type device which locks onto the casing, welded, or secured by such other device or method as may be approved by the Department. It shall be the responsibility of the owner to maintain the integrity of the protective device placed on the well opening by the well driller.

E. A well shall be drilled to a size that will permit the outer casing to be surrounded by a water tight seal a minimum of two (2) inches thick. All wells

Pages 16 - 30 intentionally left out

systems. The Department shall require the reuse of water for cooling through the use of cooling towers, evaporative condensers, or some other such device or method approved by the applicable code.

D. All residential, commercial and industrial heat pump systems, shall be a horizontal closed loop system with no discharge. The design of such heat pump system, shall be approved by the applicable code, and the owner shall have a valid mechanical permit.

E. Non-aqueous heat pump system shall be prohibited.

Section 12 -- AVAILABILITY OF PUBLIC WATER

12.01 -- Public Water Available To A Premise

A. Public water shall be deemed available to a premise other than a subdivision when it is located within three hundred (300) feet of said premise.

B. When proposed subdivisions are comprised of premises used or intended for human habitation or other establishments where a water supply is or may be used for human consumption and where such subdivision is located within one quarter (1/4) mile of public water distribution facilities in existence in a dedicated right-of-way, the developer of such subdivision shall extend the water supply mains and connect all lots thereto.

C. The distance between an existing water main in a dedicated right-of-way and a premise or proposed subdivision shall be measured by an actual or imaginary straight line upon the ground or in the air between the point within the premise or subdivision nearest to the existing water main in dedicated right-of-way and the point where the existing water main in a dedicated right-of-way comes into closest proximity with the premise or proposed subdivision.

D. The connection to a public water supply shall be made in accordance with the requirements of all applicable rules and regulations of any

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alternative water supply to the proposed well exists. The potable water supply shall be obtained from the public water system.

J. The construction of a water well or any other type of well regardless of use on a lot or premise less than four (4) acres in size utilizing a septic tank system for sewage disposal, shall not be permitted by the Department.

12.02 -- Public Water Not Available To A Premise

A. Public water shall be deemed not available to a premise if it is located a distance greater than three hundred (300) feet of said premise.

B. Public water may be deemed not available to a premise if the topography and land surface features are such that they economically or structurally prevent connecting to public water.

12.03 -- Auxiliary Intake

No auxiliary intake for/ a potable water supply shall be made or permitted unless the source and use of the auxiliary supply and the location and arrangement of the intake are approved by the Department in writing.

Section 13 -- INJECTION WELLS

No injection wells of any type shall be allowed in Memphis and Shelby County for the injection of surface or groundwater, or chemically or thermally altered water, or any other fluids into the underground formations. No well constructed shall be used for recharge, injection, or disposal purposes. Injection wells for the purpose of improving groundwater quality may be considered under Section 14.02, but approval of these wells will not release the appellant of any applicable requirements under state or federal law for the remediation of contaminated groundwater or materials at the site.

Section 14 -- VARIANCES

14.01 -- Existing Wells

Wells in existence on the effective date of this Act shall be required to conform to the provisions of these Rules and Regulations, or any rules or regulations

APPENDIX E

APPENDIX E

Surface Water Dilution of COC's in the Loosahatchie River

<IMG SRC 97183 B2>

<IMG SRC 97183 B3>

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APPENDIX F

<IMG SRC 97183 B4>

This memorandum responds to your request for a review of the report titled "Groundwater Modeling Effort to Evaluate Remedial Alternatives for Contaminated Groundwater, Arlington Blending and Packaging Site, Arlington, Tennessee". Within this memorandum, this document is identified as "the report". For your convenience, comments are referenced to specific pages or sections of the report, as applicable.

Accompanying my review of the report is an independent modeling assessment of the remedial alternatives modeled by the PRPs, contractor, as well as an evaluation of additional remedial alternatives which may be more efficacious in a ground-water remedial action. Because the goal of the EPA and the state environmental regulatory agendy is to make an informed decision regarding the appropriateness of an active ground-water remedial action at this site, it may be most advantageous for you to use this memorandum and the draft report as the support documents for such a decision, rather than to request that the PRPs provide a revised modeling report for our further consideration.

To assist you in your understanding of my report review and the independent assessment I have performed, a summary and conclusions section is included at the beginning of the body of this memorandum.

If you have any questions regarding this memorandum, or require additional technical assistance, please contact me at x28645.

Summary and Conclusions

º Based on my confirmatory modeling of the ground-water flow in the vicinity of Arlington Blending, I conclude that the PRPs' contractor's Modflow modeling analysis of the Arlington Blending vicinity is a fairly good approximation of ground-water flow. Some adjustments could, however be made which would improve the match between observed amd model-predicted ground-water elevations in the upper sand aquifer.

°I concur that the leakage of water from the upper sand aquifer to the Memphis sand aquifer (or vice versa) is inconsequential in the area of contaminated upper sand aquifer ground water, under ambient conditions. Pumping of a water-supply well in the Memphis sand in the vicinity of the upper sand aquifer ground-water contamination is unlikely to induce measurable, if any, downward migration of ground-water contaminants.

° The approach used by the PRPs' contractor to estimate ground-water remedial time frames is a valid method for determining relative time frames for different remedial options; it may generate only very approximate values for absolute remedial time frames. For this application, the modeling approach to estimate remedial time frames is only valid if significant contaminant mass is restricted to the ground water and aquifer materials in the aquifer being modeled.

° In addition to the six remedial options considered by the PRPs' contractor, I modeled five additional remedial options. The modeling results obtained by myself and the PRPs contractor are roughly the same, although my modeling indicated lower pore volume flush times for the six alternatives the PRPs' contractor modeled. Some of the additional off-property remedial alternatives I considered indicate that shorter off-property pore volume flush times are attainable than for any of the modeling simulations run the PRPs' contractor.

° I disagree with the PRPs' contractor's approach of using the maximum observed ground-water concentrations to determine the number of pore volume flushes needed to remove ground-water contaminants under different model scenarios. Instead, I used the maximum average of detects from any one well in the upper sand aquifer to predict the number of pore volume flushes required.

° Primarily because of the difference in specifying the initial concentrations of ground-water contaminants, I have determined that the number of pore volume flushes needed to remove each one of the contaminants of concern is different than the values determined by the PRPs' contractor. The difference is most significant for chlordane and pentachlorophenol for the on-property remedial evaluations. The estimates are comparable of the necessary number of off-property pore volume flushes.

° The PRPs' contractor calculated aquifer cleanup times with the assumption of no contaminant biodegradation, and with the assumption of contaminant biodegradation at a rate equal to the maximum literature-reported half life. The aquifer cleanup times calculated assuming such biodegradation are illustrative of what might be expected under the best of conditions, but may not be realistic with respect to the Arlington Blending site. Although there are some ground-water contaminants at the Arlington Blending site which are degradation products of pesticide compounds, these substances may also be product impurities which were coincidental contaminants at the facility. Among other concerns about biodegradation, lengthy plumes of contaminants such as 1,1-DCE and benzene imply that limited or no ground-water biodegradation of contaminants is occurring. Thus, this process should be considered with caution.

º I have tabulated aquifer cleanup times for all contaminants of concern, for conditions where there is no biodegradation considered, and for conditions with biodegradation. I have then compared these results to results obtained by the PRPs' contractor, and have analyzed the differences. The results of this analysis are enumerated as follows:

1. My analysis predicts shorter remedial time frames for all modeled scenarios, compared to the results obtained by the PRPs' contractor. Such, shorter time frames range from substantial differences to insignificant differences, depending on the contaminant and scenario modeled.

2. With biodegradation at a rate predicted by the maximum literature-reported half life, there is little advantage obtained by an active remedial action, versus the intrinsic degradation alternative. That is, the major process removing contaminants from the aquifer is biodegradation, not physical removal by recovery wells or natural ground-water discharge.

3. Assuming there is either no biodegradation, or biodegradation occurs at a substantially slower rate than that predicted by the maximum literature-reported half life for a contaminant, my modeling indicates there will be a significant difference in remedial time frames for one or more active remedial alternatives, compared to the intrinsic remedial alternative. Of particular significance is the off-property remediation of pentachlorophenol (potential active remedial time frame of between 40 and 50 years with no biodegradation, versus 138 years for intrinsic remediation); and on-property remediation of endrin (potential active remedial time of approximately 30 years; versus approximately 70 years for intrinsic remediation).

4. Regardless of the modeled scenario, my analysis indicates that an active remedial action to address on-property chlordane ground-water contamination may be unwarranted. With significant biodegradation, intrinsic remediation of chlordane in virtually as effective as any active remedial action. In the absence of biodegradation, remedial time frames for chlordane are predicted to be approximately 100 years or more under the most efficient on-property remedial alternative, which is in the realm of "technical impracticability". Regardless of the need for active remedial action to address the problem, monitoring of the on-property chlordane ground-water contamination is needed.

5. Because of localized concentrations only marginally above the ground-water target concentration, active remedial action to address the on-property heptachlor epoxide contamination is probably not needed.

6. A primary reason for the most significant discrepancies between my predicted remedial time frames and the PRPs' contractor's values relates to the predictions of the fate of the low mobility pesticides (chlordane, heptachlor epoxide and endrin) in areas downgradient of the property. Because of their low mobility (sorptive properties) and limited contaminant mass below the water table, I believe these compounds will migrate limited distances {if at all) downgradient of the Arlington Blending property before being diluted or partitioned to soil, such that dissolved concentrations are below levels of concern. The PRPs' contractor's analysis assumed that pore volume flushing of the entire upper sand aquifer downgradient of the property would be necessary before ground-water remedial goals would be attained.

Section 2 Ground-Water Flow Model

I concur with the use of the Modflow model to evaluate the ground-water flow patterns at and downgradient of the Arlington Blending site. I have independently run Modflow as a check on the PRPs' contractor's work. For this effort, I have generally followed the PRPs' contractor's conceptual hydrogeologic model, and have relied on the site-specific data presented in the report. I considered the same model domain and used the same grid line spacings and numbers as did the PRPs' contractor. I considered the Memphis sand in the same way as did the PRPs' contractor (a valid approach, since one is comparing remedial alternatives in the more localized flow system of the upper sand aquifer). I also considered the Loosahatchie River canal as a constant head boundary (river boundary cells). I have not included the detailed model input and output with this memorandum, as it is generally similar to the information provided in the report.

My modeling work confirms that the PRPs' contractor's ground-water flow model is basically correct, although there are some minor adjustments which could be made to improve the correlation of measured versus model-projected water levels for the steady-state condition. For example, conceptually, one would consider that ground-water recharge in the immediate vicinity of the Arlington Blending property would be slightly less than elsewhere, because of the presence of additional paved surfaces, buildings and the like, in comparison to the primarily agricultural areas to the north and south. Likewise, ground-water recharge in the immediate vicinity of the Loosahatchie River canal is negligible, and some degree of ground-water evapotranspiration is probably occurring near the stream. Additionally, modification of the transmissivity of the unit 2 aquifer (as defined in report Table 1) on a localized basis would improve the match between observed and model-predicted water levels somewhat. However, the PRPs' contractor's selected calibrated site model from Table 3, (Run C; see bottom of report page 13) is fairly close to the best fit results I have obtained, using slightly modified transmissivity and recharge values in localized parts of the mode domain. A comparison of results is presented in Table 1. Figure 1 of this memorandum shows the hydraulic head distribution in the upper sand for the calibrated flow model I ran.

Table 1 Comparison of the Report Calibrated Model Results with My Calibrated Model Results

Report Calibrated Model:

Unit 2 aquifer transmissivity: 2000 ft 2/d
Unit 2 recharge: 0.00067 ft/d
reported correlation coefficient: 0.975
RMS error (see report Figure 8): 0.872

My calibrated model:

Unit 2 aquifer transmissivity: rows 30 through 35, columns 6 through 47, 1500 ft 2/d; rows 25 through 29, colums 6 through 47, 1800 ft 2/d; elsewhere, 2000 ft 2/d
Unit 2 recharge: rows 41 through 46, columns 6 through 47, 0.0004566 ft/d; river (boundary) cells + 3 rows north and south of each river cell 0 ft/d; elsewhere 0.000685 ft/d.
calculated correlation coefficient: 0.987
RMS error (Figure 2 of this memorandum) = 0.797.

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I have also run a mass balance analysis and concur with the conclusion presented in Section 2.6, page 14, that leakage of water from the Memphis sand aquifer into the upper sand aquifer (or vice versa) is inconsequential in the area of concern under ambient conditions.

Section 3 Evaluation of Remedial Alternatives

Section 3 of the report first presents the approach used to estimate time frames for various remedial alternatives which are considered for the Arlington Blending ground-water remedial action. I concur with the approach that was selected for this evaluation (as per a copy of my memorandum to you dated January 29, 1996, presented in Appendix C). However, I do note for the record that the selected approach should be considered to give rough estimates of ground-water remedial time frames and may therefore best be considered in relative rather than absolute terms. Also, for ground water, the method used to calculate remedial time frames assumes that the source of contamination has been effectively removed, so that essentially all the contaminant mass is in the ground water and aquifer materials of the upper sand aquifer. It is my understanding that this condition has been met at this site.

Section 3.1 Modeling

Section 3.1 of the report presents the results of modeling (using Modflow/Modpath) of six remedial alternatives. I have run these six simulations, as well as five additional remedial design configurations, for further comparison to the intrinsic remediation conditions. For the intrinsic remediation condition, I used the calibrated flow model I have developed (as described on the previous page), in place of the calibrated model developed by the PRPs' contractor.

For the eleven remedial alternative simulations I ran, the following conditions apply:

simulations 1 through 6 are the same as simulations 1 through 6 as defined in the report Table 4.

simulation 7 is the same as simulation 2, but with three additional off-site recovery wells: row 33, col. 22, Q = -3850.3 ft 3/d; row 23, col. 22 Q = -3850.3 ft 3/d; row 12, col. 20, Q = -3850.3 ft 3/d.
simulation 8 is the same as simulation 2 but with eight

additional off-site recovery wells: row 31, cols. 19-22, Q = -2887.7 ft 3/d; row 14, cols. 19-22, Q = -2887.7 ft 3/d.

simulation 9 is the same as simulation 2 but with four recharge wells: row 39, cols. 16,19,21 and 24, Q/well = 2887.7 ft 3/d {same as simulation 6, but different location of recharge wells.

simulation 10 is like simulation 2 but with 5 recharge wells: row 38, cols. 16, 18, 20, 22, 24, Q/recharge well = 2310.2 ft 3/d.

simulation 11 is like simulation 10 but with one additional well at row 13, col. 20, Q = -3850.3 ft 3/d.

For each remedial alternative, I have calculated the time required to remove 1 pore volume in a manner similar to the PRPs' contractor. Because of some computer hardware limitations, my approach was slightly different (forward Modpath particlel tracking, versus backward tracking which is the preferred technique). My analysis yielded results which are rougher estimates, in terms of predicting pore volume flush times which would be estimated by each model simalation. However, I believe that my baseline calibrated model is probably more accurate that the PRPs' contractor's, which should yield somewhat better estimates of pore volum flush times. I have considered the "on-property" condition to represent the area within the capture zone for on-property recovery wells, with the exception of the intrinsic flow condition, where on-property was considered to extend to the vicinity of monitoring wells just across U.S. Highway 70 from the property. For the intrinsic condition, the time for 1 pore volume flush of on-property ground water was the time required for a simulated particle to move from the upgradient Arlington Blending property line to the downgradient margin of the area defined as on-property.

The results of my modeling of times required for 1 pore volume flush are presented in Table 2 of this memorandum. Appendix A shows figures prepared for each of the 11 model simulations, considering both on-property and off-property conditions.

Discussion of Results

Table 2 of this memorandum can be compared to Table 5 of the report. Both my modeling and the modeling by the PRPs' contractor indicates that certain configurations of recovery wells will increase the time for one pore volume flush to occur in areas downgradient of the Arlington Blending property. My modeling indicates shorter time periods for a pore volume flush than predicted by the PRPs' contractor, for all of the six

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Table 5 of the report does not include projected on-property pore volume flush times for simulations 1, 4, 5, or 6. The time for one on-property pore volume flush is probably significant with respect to the low mobility ground-water contaminants which are currently restricted to within the property. My modeling predicted slightly different on-property pore volume flush times for alternatives 4, 5, and 6, which is consistent with variable configurations of recovery and injection wells.

The additional simulations I performed provide further insight into the potential optimal configuration of recovery wells. Simulations 2B and 2C reduce the discharge rate for the four on-property recovery wells modeled in simulation 2. A reduction in discharge of on-property recovery wells would decrease the off-property pore volume flush time, to near ambient conditions. However, there is a trade off between the time required for one pore volume flush of contaminated ground water in the capture zone of the on-property wells and the time required for one pore volume-flush in the areas downgradient of the on-site recovery well capture zones. Reinjection of contaminated ground water downgradient of the site would decrease the time required for one pore volume flush of off-property ground water. Additional off-property recovery wells could reduce the time required for one pore volume flush of contaminated off-property ground water to between 40 and 50% of the time required for one pore volume flush of contaminated off-propert ground water under ambient conditions. Clearly, some of the simulations I ran which were not considered by the PRPs' contractor result in more efficient removal of off-property contaminated ground water than the five pumping or pumping/reinjection options considered by the PRPs' contractor.

Section 3.2 Number of Pore Volume Flushes

Section 3.2 presents the equation (batch flushing model) used to estimate the number of pore volume flushes required to reduce ground-water contaminant concentrations from an initial value to a specified end point. The text at the top of page 23 states that the batch flushing model approach is very conservative, because other potential factors affecting ground-water transport, specifically biodegradation, are not considered. Later, in Section 3.3.1, an equation is presented which incorporates biodegradation into the calculation of remedial time frames. I concur with the PRPs' contractor's use of the equation in Section 3.3.1 to estimate aquifer cleanup times for the biodegradation case. However, the interpretation of data from modeling which incorporates biodegradation must be considered cautiously. This issue is further discussed in this memorandum in a review of Section 3.3 of the report.

Initial Concentrations (Report Sections 3.2.1 and 3.2.2)

For the calculation of pore volume flushes required, the PRPs' contractor used the maximum historical ground-water concentrations to estimate an initial ground-water concentration in the batch flush modeling. This approach is probably overly conservative. I make this conclusion because of the following reasons:

° Maximum historical concentrations may represent conditions which are no longer extant (due to biodegradation or contaminant dispersal over time).

° The highest ground-water concentrations observed may have been from shallow wells in locations which were part of the soil remedial action at the site (i.e. the highly contaminated ground-water samples were derived from shallow saturated soils which were removed).

° The highest concentrations of contaminants detected in ground-water samples may have resulted from either earlier ground-water sampling techniques (high-rate purging of wells) or incomplete well development, which could have resulted in withdrawal of aquifer materials containing sorbed contaminants.

A conservative alternative approach I used was to consider the highest average (of detects) concentration in any on-site or off-site monitoring location in the sand aquifer. This approach may also over-estimate the remedial time frames required, since it does not completely eliminate the concerns related to changing environmental conditions at the site, or sampling technique/well development. However, "spikes" in contaminant concentrations which may be a result of those conditions (for example, the 79 ug/L chlordane concentration in a sample from well AB-3D) are not exclusively used to predict remedial time frames. Table 3 of this memorandum presents the concentrations I selected as initial values for calculating remedial time frames using the batch flushing model, or modified batch flushing approach to account for possible biodegradation below the water table.

Table 3. Maximum Average Concentrations in the Upper Sand Aquifer

On-property wells

constituent	maximum average of detects/well represented
PCP	1016 ug/L (well OW-2A)
benzene	50.4 ug/L (well OW-2A)

1,1 -DCE	22.6 ug/L (well AB-2D)

Table 3, continued

constituent	maximum average of detects/well represented
chlordane	32.3 (well AB-3D)
endrin	7.8 ug/L (well OW-1A)
heptachlor epoxide	0.273 (well AB-7D)

Off-property

constituent	maximum average of detects/well represented
PCP	345 ug/L (well AB-13D)
benzene	12.7 ug/L (well AB-13D)
1,1-DCE	27.3 ug/L (well AB-9D)

Retardation Coefficients (Report Section 3.2.3)

With the exception of pentachlorophenol, Koc values used by the PRPs' contractor are values from a reference by Jeng, et al, 1992. A more recent US EPA reference, Soil Screening Guidance: Technical Background Document (US EPA Office of Emergency and Remedial Response, Washington DC, Publication 9355.4 -17A, 1996) presents some Koc data which I used in place of the PRPs' contractor's Koc values shown in report Table 8. Values I used are included in Table 4 of this memorandum.

Table 4. Koc Values

constituent	reported average Koc (from Table 38, US EPA, 1996)
PCP	use PRPS' contractor's value of 1,439
benzene	66
1,1-DCE	65
chlordane	51,798
endrin	11,422
heptachlor epoxide	use PRPs' contractor's value of 7,236

To calculate the soil-water partitioning coefficient, K, and the retardation coefficient, I used the PRPs' contractor's value of 0.00037 for the fraction of organic carbon, and the values of 1.5 g/cm 3 for bulk density and 0.39 for porosity (see bottom of report page 25). Combined with the Koc values from Table 4 of this memorandum, use of these values resulted in the K and retardation coefficient presented in Table 5 of this memorandum.

Table 5. Kd and Retardation Coefficient Values

constituent	Ed	Rgtardation coefficient
Pcp	0.53	3.05
benzene	0.024	1.09
1,1-DCE	0.024	1.09
chlordane	19.17	74.7
endrin	4.23	17.3
heptachlor epoxide	2.68	11.30

Based on the retardation coefficients and maximum average-ground water-concentrations presented in Table 3 and Table 5 of this memorandum, I have calculated the required number of pore volume flushes required to remediate the ground-water in the upper sand aquifer to the ground-water performance standards, assuming no biodegradation is occurring. As did the PRPs' contractor, I used the equation presented in report 3.2, bottom of page 22. My results in Table 6 of this memorandum can be compared to Table 9 of the report. The results for the off-property conditions are very similar; my analysis indicates fewer pore volume flushes will be required for the on-property remedial action, although the number of required pore volume flushes for chlordane is stil very high.

Table 6. Number of Pore Volume Flushes

contaminant	on-property	off-property
PCP	21	18
benzene	2.5	1.6
1,1-DCE	1.3	1.48
chlordane	208	
endrin	63.4	
heptachlor epoxide	3.5	

Section 3.3 Aquifer Cleanup Times

Biodegradation Analysis

Biodegradation may be occurring at the site. There are site-specific data from the Remedial Investigation Report (US EPA, 1990) which suggest biodegradation of some organic contaminants has occurred. Specifically, ground-water detections of heptachlor epoxide, endrin ketone, oxychlordane,,and tetrachlorophenol are possible or probable indicators of biodegradation of heptachlor, endrin, and pentachlorophenol, Some of these compounds may however represent impurities in the pesticides which were released to the subsurface during the facility operations. For the more mobile volatile organic compounds, one must question the presence of significant biodegradation, considering the very long contaminant plumes which have developed downgradient of the Arlington Blending site, and the absence of significant volatile organic compound concentration decreases in several monitoring locations over the life of site monitoring (see report Appendix E, data for wells AB-2D AB-9D, AB-13D, AB-15D).

As another example of this concern about biodegradation of the volatile organic compounds, considering the estimated pore volume flush time of 7.67 years I calculated for ambient conditions

(Table 2 of this memorandum), a retardation factor of 1.09 years for 1,1-DCE (Table 5 of this memorandum), and the reported maximum 0.362-year 1,1-DCE half life (report Table 10), 1,1-DCE transported in the upper sand aquifer to the location of monitoring well AB-9D should have gone through approximately 23 half lives along its transport path downgradient of the Arlington Blending property. Considering the average concentration of 1,1-DCE detected in samples from well AB-9D (27.3 ug/L; see memorandum Table 3), the initial ground-water concentration producing 27.3 ug/L through 20 half lives is calculated to be more than 200,000 mg/L. There is no evidence for on-property concentrations of 1,1-DCE or related chlorinated organic solvents approaching such concentrations in soil or ground-water samples from the Arlington Blending property.

Consistent with the PRPs' contractor's approach, one can consider biodegradation processes for the sake of comparison of remedial times for the various ground-water remedial alternatives. However, one should consider that predicted remedial time frames incorporating biodegradation may predominantly be influenced by a process which is not occurring in the ground water, or which may be occurring at a rate less than that reported in the literature. Thus, the remedial time frames calculated for the biodegradation case should be assumed to represent the low-end estimate of the remedial time frames which may be attainable for the various remedial options.

Biodegradation half lives presented in Table 10 of the report are acceptable for this analysis, with the possible exception of endrin. Available literature references indicate potential half-life of endrin in soils is as much as 14 years (ATSDR Toxicological Profile for Endrin/Endrin Aldehyde; Howard, Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume III). A half life of 14 years is equivalent to a biodegradation rate coefficient of 0.0495/y. I have only considered biodegradation for the less mobile pesticide compounds, since these compounds are most critical to a comparison of remedial time frames, and there is evidence which suggests that significant biodegradation of the volatile organic compounds is not occurring at this site.

Tabulations of Aquifer Cleanup Times

The following series of tables present my calculations of aquifer cleanup times on a contaminant-specific basis, for each of the eleven remedial scenarios I modeled. These tables are arranged differently, but can be compared to report Tables 11 through 14. A comparison and analysis is made on a contaminant by contaminant basis, following the tables.

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aquifer cleanup times- no biodegradation

contaminant: benzene 2.5 on-property PV flushes, 1.6 off-property PV flushes

remedial scenario #	estimated remedial cleanup time, years	
	on-property	off-property
1 (intrinsic remediation)	2.8	12.3

2	1.1	15.6
2B	1.5	12.7
2C	1.3	12.8
3	1.6	13.6
4	1.2	12.5
5	1.8	6.2
6	1.1	10.3
7	1.4	4.8
8	1.8	3.9
9	1.2	9.3
10	2	8
11	2.3	7.9

aquifer cleanup times- no biodegradation

contaminant: 1,1-DCE 1.3 on-property PV flushes, 1.48 off-property PV flushes

remedial scenario #	estimated remedial cleanup time, years	
	on-property	off-property
1 (intrinsic remediation)	1.4	11.4
2	0.6	14.4
2B	0.8	11.8
2C	0.7	11.8
3	0.8	12.6
4	0.6	11.6
5	0.9	5.7
6	0.6	9.5
7	0.7	4.5
8	0.9	3.6
9	0.6	8.6
10	1	7.4
11	1.2	7.3

aquifer cleanup times- no biodegradation

contaminant: haptachlor epoxide 3.5 on-property PV flushes

remedial scenario #	estimated remedial c1eanup time, years
	on-property
1 (intrinsic remediation)	3.85
2	1.6
2B	2.1
2C	1.9
3	2.2
4	1.6
5	2.5
6	1.5
7	2
8	2.5
9	1.7
10	2.8
11	3.3

aquifer cleanup times- biodegradation

contaminants: heptachlor epoxide

remedial scenario-# estimated remedial cleanup time, years

	on-property
1 (intrinsic remediation)	1.0
2	0.6
2B	0.8
2C	0.8
3	0.8
4	0.7
5	0.9
6	0.7
7	0.8
8	0.9
9	0.8
10	1.0
11	1.0

aquifer cleanup times- no biodegradation

contaminant: chlordane 208 on-property PV flushes

remedial scenario-#	estimated remedial cleanup time,years
	on-property
1 (intrinsic remediation)	229
2	93.6
2B	125
2C	110
3	131
4	96
5	147
6	92
7	118
8	147
9	102
10	166
11	193

aquifer cleanup times- biodegradation

contaminant: chlordane

remedial scenario #	estimated remedial cleanup time, years
	on-property
1 (intrinsic remediation)	26.9
2	23
2B	24.5
2C	23.9
3	24.8
4	23.1
5	25.3
6	22.9
7	24.3
8	25.3
9	23.5
10	25.8
11	26.4

aquifer cleanup times- no biodegradation

contaminant = endrin 63.4 on-property PV flushes

	on-property
1 (intrinsic remediation)	69.7
2	28.5
2B	38
2C	33.6
3	39.9
4	29.2
5	45
6	27.9
7	36.1
8	45
9	31.1
10	50.7
11	59

aquifer cleanup times, biodegradation

contaminant: endrin

remedial scenario #	estimated remedial cleanup time, years
	on-property
1 (intrinsic remediation)	35.9
2	20.6
2B	25.1
2C	23.1
3	25.9
4	20.9
5	28
6	20.2
7	24.2
8	28
9	21.9
10	30.1
11	32.8

Pentachlorophenol Comparison and Analysis

The PRPs' contractor determined an aquifer cleanup time of 308 years for the intrinsic remediation alternative without biodegradation, and a cleanup time of 48 years with biodegradation (report Table 11) . My analysis determined an aquifer cleanup time of 138 years without biodegradation and 28.1 years with biodegradation for the pentachlorophenol remediation. - Report Tables 13 and 14 present remedial time frames for off-property intrinsic remediation of 255 and 33 years, without and with biodegradation respectively. My analysis presents a range of off-property intrinsic remedial time frames, depending on the on-property pumping plan considered. For example, for conditions simulated by ground-water flow model scenario 2 (memorandum Table 2), I predict off-property cleanup times of 175 years and 29.4 years,respectively for no biodegradation and biodegradation conditions. However, for the lower pumping rates modeled in scenario 2B, the times required for off-site intrinsic remediation are closer to the time frames for intrinsic remediation of the entire plume.

For conditions where biodegradation is assumed, there is relatively little advantage obtained by an active ground-water remedial action. For the overall most efficacious active remedial alternatives considered (simulations 7 and 8), predicted aquifer cleanup times are reduced from 15 years to approximately 9 to 11 years for on-property remediation, and from 28.1 to approximately 20 years for off-property remediation.

Where biodegradation is not considered, there is a more dramatic difference, particularly for the off-property remedial time frame. For alternative 8, the predicted remedial time frame for off-property pentachlorophenol contamination decreases from 138 years to 44 years. With a very low degree of biodegradation, an active ground-water remedial action may attain remedial goals in a reasonable time frame (roaghly somewhere between 20 to 30 years), while an intrinsic remedial alternative may not attain remedial goals in the off-property part of the plume in less than 50 years.

Benzene Comparison and Analysis

The PRPs' contractor determined an aquifer cleanup time of 32 years for the intrinsic remediation alternative without biodegradation, and a cleanup time of 7 years with biodegradation (report Table 11). My analysis determined an aquifer cleanup time of 12.3 years without biodegradation; I did not consider biodegradation but it would result in a predicted remedial time comparable to the PRPs' contractor's 3-year time frame. Report Tables 13 and 14 present remedial time frames for off-property intrinsic remediation of 12 and 2 years, without and with biodegradation respectively. My analysis presents a range of off-property remedial time frames, depending on the on-property pumping plan considered. Without biodegradation , the off-property aquifer cleanup times for benzene could be reduced from about 12 to 16 years for completely intrinsic off-property remediation to between 4 and 5 years, for the most effective active off-property remedial alternatives considered.

Considering the much longer times required for remediation of pentachlorophenol under any of the remedial alternatives, it is unnecessary to include additional discussion of remediation of the benzene contamination in this memorandum.

1,1-DCE Comparison and Analysis

The PRPs' contractor determined an aquifer cleanup time of 21 years for the intrinsic remediation alternative without biodegradation, and a cleanup time of 1 year with biodegradation (report Table 11}. My analysis determined an aquifer cleanup time of 11.4 years without biodegradation for the intrinsic remediation alternative. My analysis presents a range of off-property remedial time frames, depending on the on-property pumping plan considered. Without biodegradation, the off property aquifer cleanup times for 1,1-DCE could be reduced from about 11 to 15 years for completely off-property intrinsic remediation to between 4 and 5 years for the most effective active off-property remedial alternatives considered. Considering the much longer times required for remediation of pentachlorophenol under any of the remedial alternatives, further discussion of the 1,1-DCE contamination is unnecessary.

Heptachlor Epoxide Comparison and Analysis

The highest detected level of heptachlor epoxide is only marginally above the ground-water remedial goal concentration (0.273 ug/L versus 0.2 ug/L). Based on this difference, the time required for on-property remediation of this compound would not be expected to be substantial. The PRPs' contractor predicted the number of pore volume flushes required to reduce this compound to the ground-water target concentration would be 4, while my analysis indicated 3.5 on-property flushes would be required. Under an intrinsic remediation alternative without biodegradation, the PRPs' contractor determined an aquifer cleanup time of 43 years, whereas I determined a remedial time of only 3.85 years. The difference between these estimates partly relates to the consideration of the fate of heptachlor epoxide downgradient of the Arlington Blending property. Based on an evaluation of available ground-water data, I have concluded that there is probably insufficient heptachlor epoxide mass in the ground water or saturated soils beneath the property to cause future off-property contamination above the ground-water remedial goal of 0.2 ug/L. Thus, on-property flushing of heptachlor should result in adequate remediation of the heptachlor epoxide ground-water contamination within a few years. There is probably very little to be gained by an on-property active remedial action to address the heptachlor epoxide contamination.

Chlordane Comparison and Analysis

The PRPs' contractor determined an aquifer cleanup time of 2,892 years for the intrinsic remediation alternative without biodegradation, and a cleanup time of 40 years with biodegradation (report Table 11). My analysis determined an aquifer cleanup time of 229 years without biodegradation and 26.9 years with biodegradation for the chlordane remediation. Similar to the situation for heptachlor epoxide, the large discrepancy between my estimate and the PRPs' contractor's estimate relates to the potential for off-property migration of chlordane. Based on my analysis of data for on-property chlordane contamination, and considering the low mobility of this compound, there is little likelihood that a chlordane plume will extend for any significant distance downgradient from the property. Thus, the entire aquifer downgradient of the property would probably not have to be flushed over 200 times in order to reduce chlordane concentrations to below ground-water target levels throughout the area of concern.

However, my analysis does indicate that in the absence of biodegradation, a very long time will probably be needed to reduce chlordane concentrations to below target levels throughout the area of ground-water chlordane contamination. The most efficacious on-property remedial alternative may not reduce chlordane concentrations to acceptable, concentrations for almost 100 years, if there is no significant biodegradation. Conversely, if there is significant biodegradation such as that modeled in this memorandum, there is little to be gained in, chlordane remediation for an active remedial alternative, versus the intrinsic remedial alternative (the predicted aquifer cleanup time would decrease from approximately 27 years to approximately 23 years}. Thus, one might conclude that remediation of the ground-water chlordane contamination is either ill-advised not warranted (i.e. is either unnecessary if there is significant biodegradation, or is "technically impracticable", if there is no biodegradation}. There may be some intermediate condition of very minimal biodegradation where there is more advantage to an active remedial action for chlordane; also, should the chlordane mobility and contaminant mass conditions be less favorable than I believe, there may be some need to contain this chlordane contamination to within the property. However, one could conclude from this analysis that the chlordane ground-water contamination would be best monitored rather than directly addressed through any active ground-water remedial action until and unless conditions change.

Endrin Comparison and Analysis

The PRPs' contractor determined an aquifer cleanup time of 755 years for the intrinsic remediation alternative without biodegradation, and a cleanup time of 45 years with biodegradation (report Table 11). My analysis determined an aquifer cleanup time of 69.7 years without biodegradation and 35.9 years with biodegradation, for the intrinsic endrin remediation. The discrepancy again relates to the PRPs' contractor's assumption that the endrin will spread into areas downgradient of the property and must be flushed out of the aquifer at the ground-water discharge area along the Loosahatchie River canal, versus my conclusion that such contamination is unlikely to occur. Regardless, there appear to be advantages to on-property active remedial action to address this compound, if there is no biodegradation occurring in the ground water. My analysis indicates that remediation of the on-property endrin ground-water contamination can be reduced from approximately 70 years to approximately 30 years, in the absence of significant biodegradation.

As for other contaminants, there is relatively less advantage for an active remedial action if there is significant biodegradation of endrin. However, there is probably more advantage to an active remedial option for endrin than for the other low mobility pesticides chlordane and heptachlor epoxide. Cleanup times for an active on-property remedial action to address endrin contamination may be reduced by roughly 40% if there is biodegradation occurring to the degree considered in the modeling; reduction in cleanup time is predicted to be approximately 15% at most for chlordane, while the heptachlor epoxide contamination should decrease to below target concentrations in a year or less, regardless of the remedial alternative considered.

Section 4.0 Memphis Sand Pumping Simulations

I have not independently modeled the conditions which would occur under this aquifer pumping scenario. However, based on the available site data and the conceptual model presented elsewhere in the report, as well as volumes of leakage calculated by the calibrated Modflow model for the ambient conditions, I concur that there should be an insignificant amount of leakage from the upper sand aquifer to the Memphis sand aquifer in the area of concern.

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Appendix A

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<IMG SRC 97183 C>

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